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On the Waxing and Waning of Working Memory: Action Orientation Moderates the Impact of Demanding Relationship Primes on Working Memory Capacity

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The present research examined how action- versus state-oriented individuals (Kuhl & Beckmann, 1994) utilize their working memory capacity under varying situational demands. Participants visualized either a demanding or an accepting person, after which their working memory capacity was assessed. Among action-oriented participants, visualizing a demanding person led to greater operation spans (Study 1) and superior memory for intention-related information (Study 2) than visualizing an accepting person. State-oriented participants displayed the opposite pattern, such that visualizing an accepting person led to greater operation spans (Study 1) and superior memory for intentions (Study 2) than visualizing a demanding person. These findings indicate that action versus state orientation moderates the impact of situational demands on working memory capacity.

Keywords: *working memory capacity; action orientation; state orientation; relationship schemas*

The ability to remember the right things at the right time is often critical for achieving one's goals. For instance, remembering the departure time of one's train, the name of the restaurant where one is supposed to meet a business associate, or that one should buy a birthday present for one's partner all help to avoid decidedly unpleasant experiences. Unfortunately, various circumstances, such as unexpected phone calls, heavy workloads, or pressing social commitments, often make it necessary to consider many things simultaneously (Shah, Kruglanski, & Friedman, 2003), leaving train schedules, restaurant names, and birthday presents candidates for unwitting neglect (Reason & Mycielska, 1982). To prevent long delays, lost business, disappointed partners, and other misfortunes, people need to rely on their working memory capacity (Engle, Kane, & Tuholski, 1999).

Working memory capacity is an immensely useful psychological resource that allows people to remember important information even when they are temporarily distracted. Past research and theorizing make inconsistent predictions regarding the effects of situational demands on working memory capacity. On one hand, people may utilize their working memory capacity less efficiently under high demands (e.g., Baumeister, 1984). On the other hand, high demands may lead people to mobilize greater control resources and thereby utilizing their working memory capacity more efficiently (e.g., Botvinick, Braver, Barch, Carter, & Cohen, 2001). In the present research, we suggest a possible way to reconcile these conflicting notions. Based on *personality systems interactions* (PSI) theory (Kuhl, 2000, 2001), we propose that the effects of situational demands on working memory capacity are moderated by action versus state orientation.

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Action-oriented individuals utilize their working memory capacity more efficiently in high-demanding situations, whereas state-oriented individuals utilize their working memory capacity less efficiently in high-demanding situations. In the following paragraphs, we begin by reviewing the literatures on working memory capacity and action versus state orientation. We then present two experiments that tested our theoretical analysis.

How Working Memory Works

Working memory protects stored information against premature loss due to strong distracters (Baddeley, 1986; Engle et al., 1999; cf. Miyake & Shah, 1999). This vital task involves both short-term storage and attentional processes. Stored information in working memory is unlikely to be consciously represented at all times. Instead, such information persists in a state of heightened activation that makes it explicitly available to conscious awareness. Due to capacity constraints, working memory can only process a limited amount of explicit information simultaneously.

Working memory capacity is especially important when people have to remember what to do. Oftentimes, people have to postpone their intentions because they cannot enact them immediately (Kvavilashvili, 1987). To the extent that the intended action is novel, difficult, or can be easily forgotten, the intention needs to remain represented in an explicit format until the situation is appropriate for enactment. Given that working memory supports such explicit formats (Baddeley, 1986), working memory is intimately involved in the maintenance of explicit intentions in memory (Kane & Engle, 2003). The latter function is known as *intention memory* (Kuhl, 2000). There are some subtle differences between intention memory and working memory (for a discussion, see Kazén & Kuhl, 2005; Kuhl & Kazén, 1999). Nevertheless, intention memory and working memory both rely on the same limited mental resources and are supported by partly overlapping brain structures (e.g., left prefrontal cortex; cf. Fuster, 1995). In recognition of the important functional parallels between the two memory systems, we emphasize the similarities between working memory and intention memory in the present context.

One of the most popular measures of working memory capacity is the Operation Span (OSPAN) task (Turner & Engle, 1989). In the OSPAN task, participants are required to calculate simple arithmetic equations while retaining short series of words in memory for later recall. Working memory capacity is reflected by a person's span, that is, the number of words that can be recalled correctly while performing the calculations. Using various kinds of span tasks, research has shown that there exist substantial individual differences in working memory capacity. Relative to individuals with small memory spans, individuals with large memory spans display greater resistance to distraction, higher general fluid intelligence, and better academic achievement (for a review, see Feldman Barrett, Tugade, & Engle, 2004).

The Dual Role of Demand

Depending on situational factors, people may not always be able to utilize their working memory capacity efficiently (cf. Eysenck & Calvo, 1992). Based on previous research and theorizing (Braver & Cohen, 2000; Kuhl, 2000; Van der Linden, Frese, & Meijman, 2003), we suggest that people may utilize their working memory capacity less efficiently under conditions of sustained working memory load. Sustained working memory load may impair the updating function of working memory such that situation-irrelevant information cannot be erased and new tasks cannot be properly processed. In the present context, we refer to conditions of sustained working memory load as *high demanding*. By contrast, we term conditions without such load as *low demanding*.

High demands may leave less working memory capacity available in a variety of everyday life situations or experimental settings such as during the activation of difficult intentions (Kuhl & Helle, 1986), or multiple incompatible goals (Shah et al., 2003), in the presence of demanding relationships (Baldwin, Carrell, & Lopez, 1990), or after prolonged engagement in tasks that require continuous working memory activation (Lorist, Boksem, & Ridderinkhof, 2005). In line with this idea, previous research has found that people utilize their working memory capacity less efficiently as a result of stressful life events (Klein & Boals, 2001), mental fatigue (Van der Linden et al., 2003), ego depletion (Schmeichel, Vohs, & Baumeister, 2003), or when people try to overcome strong impulses (Zwaan & Truitt, 1998). Evidence thus suggests that working memory is prone to "choking under pressure" (Baumeister, 1984).

The notion that people better utilize their working memory capacity under low rather than high demands is intuitively plausible. However, high demands may not always have a negative impact on working memory capacity. When people encounter high-demanding conditions, this may signal to people that their current amount of working memory capacity is not sufficient. In response, people may channel more resources to their working memory, thereby utilizing their working memory capacity more efficiently under high demands. This idea is consistent with recent notions of top-down control processes. Contemporary theories of action control (Gollwitzer, 1996; Kuhl, 1984; Moskowitz, Li, & Kirk, 2004) assume that people more intensively shield their intentions against unwitting loss when they experience or anticipate difficulties to enact their intentions. Furthermore, neuropsychological research indicates that the detection of conflict in information processing can lead to compensatory strengthening of cognitive control in Stroop-like interference tasks (Botvinick et al., 2001). Thus, to the extent that working memory capacity is implicated in action control and cognitive control, people may better utilize their working memory capacity under high demands.

Regulation of Working Memory: The Case of Action Versus State Orientation

It appears that high demands can either undermine or facilitate working memory. As such, there likely exist moderating variables that determine the direction of the impact of situational demands on working memory capacity. One such moderator may be the person's disposition toward action versus state orientation (Kuhl, 1984, 1994, 2000; Kuhl & Beckmann, 1994). Action orientation is conceived as a *metastatic* (change promoting) regulatory mode that is characterized by decisiveness and initiative. Action orientation thus facilitates intentional action. By contrast, state orientation is conceived as a *cata-static* (change preventing) regulatory mode that is characterized by indecisiveness and hesitation. State orientation thus leads to the perseverance of current behavioral and mental states. In other words, action versus state orientation reflects the person's ability to induce the behavioral and mental changes to terminate the status quo (Kuhl, 1984). According to PSI theory (Kuhl, 1994, 2000), action versus state orientation varies chronically between individuals, such that some individuals are more action-oriented, whereas others are more state-oriented.

Action versus state orientation is distinct from classic motivational constructs (Kuhl, 1984). More specifically, classic motivational constructs refer to people's preferences to select a particular class of motivational tendencies. For instance, people may choose to pursue mastery goals or performance goals (Elliot & McGregor, 2001), adopt a promotion focus or a prevention focus (Higgins, 1998), or be driven by implicit or explicit needs (McClelland, Koestner, & Weinberger, 1989). By contrast, action versus state orientation refers to the efficiency with which people can instigate the behavioral and mental changes necessary to enact a particular motivational tendency. Consequently, action orientation can increase the enactment of any motivational tendencies that involve making difficult behavioral and mental changes. Consistent with this reasoning, action- compared to state-oriented individuals are more efficient on both mastery and performance goals (Diefendorff, 2004), report having more success in both promotion and prevention goals (Koole, 2005),[1] and are more successful at reconciling their implicit and explicit needs (Baumann, Kaschel, & Kuhl, 2005). In short, both theoretical and empirical considerations indicate that the impact of action versus state orientation occurs over and above classic motivation constructs.

Particularly relevant in the present context, action- versus state-oriented individuals have been found to respond very differently to situational demands. When confronted with increased demands, action-oriented individuals tend to mobilize their self-regulatory resources. For instance, relative to their state-oriented counterparts, action-oriented college students are better able to organize the multiple demands of college life (Diefendorff et al., 1998). In addition, action-oriented individuals better regulate their affective states under high demands (Koole & Jostmann, 2004; cf. Jostmann, Koole, Van der Wulp, & Fockenberg, 2005). Finally, action-oriented individuals maintain or even increase their task performance under demanding conditions (Heckhausen & Strang, 1988). By contrast, state-oriented individuals tend to choke under increasing demands (Heckhausen & Strang, 1988). Notably, state-oriented individuals do not necessarily display performance deficits under low-demanding conditions. Indeed, state-oriented individuals may outperform action-oriented individuals under supportive conditions, presumably because state-oriented individuals are more receptive to external motivational support (Koole, Kuhl, Jostmann, & Vohs, 2005).

Given that action versus state orientation generally moderates how people are coping with demands, it stands to reason that action versus state orientation also may moderate the impact of demands on working memory capacity. Specifically, the indecisiveness and hesitation that are characteristic of state-oriented individuals may translate into a tendency to maintain stored information in working memory even when quick decisions and initiative are more desirable (Stiensmeier-Pelster, 1994). State-oriented individuals indeed have been found to display a general tendency to engage their working memory capacity (cf. Goschke & Kuhl, 1993). Whenever an additional working memory load is externally induced under high demands (e.g., through stressful life events), state-oriented individuals are likely to remain under such load, thereby decreasing the working memory capacity that is available for subsequent tasks (Jostmann & Koole, 2006). Consequently, state-oriented individuals may utilize their working memory capacity less efficiently under high demands.

By contrast, action-oriented individuals are likely to use their working memory capacity more efficiently with increasing demands. This mobilization pattern is likely due to the decisiveness and initiative that characterize action-oriented individuals (Kuhl, 1984), which should help these individuals to reduce the duration and severity of working memory load. Accordingly, when working memory load is induced under high demands, action-oriented individuals are likely to terminate this load as soon as task requirements permit. High demands may thus activate action-oriented individuals' tendency to update their working memory, thereby making more working memory capacity available for subsequent tasks (Jostmann & Koole, 2006; Stiensmeier-Pelster, 1994). By regularly updating the contents of their working memory, action-oriented individuals are likely to better utilize their working memory capacity under high demands.

It is important to note that the preceding functional differences between action- and state-oriented individuals only apply to high-demanding conditions. Low-demanding conditions put less strain on working memory so that the functional advantage of action-oriented individuals will diminish with lower levels of demand. In fact, some low-demanding contexts may even provide state-oriented individuals with a functional advantage. Such benefits of state orientation are especially likely to occur when the situational context is rewarding. The experience or anticipation of rewards is conducive to the updating of information in working memory (cf. Braver & Cohen, 2000; Dreisbach & Goschke, 2004). State-oriented individuals are more receptive than action-oriented individuals to externally provided incentives (cf. Koole et al., 2005). A rewarding context may therefore allow especially state-oriented individuals to free up their working memory capacity.

The Present Research and Hypotheses

The present research sought to provide the first systematic empirical test of the idea that action versus state orientation moderates the impact of situational demands on working memory capacity. To induce high or low levels of situational demands, we primed a demanding or accepting relationship schema (Baldwin & Sinclair, 1996; Koole & Jostmann, 2004). Previous research found that priming mental representations of relationships with a significant other activates a host of goals, expectations, and self-evaluations that characterize the interaction with that person (Baldwin et al., 1990; Fitzsimons & Bargh, 2003; Shah, 2003; cf. Chen, Boucher, & Tapias, 2006). Building upon these findings, we reasoned that the activation of relationship schemas also would have consequences for working memory capacity. Specifically, priming one's relationship with a demanding other likely puts a high strain on working memory, thereby exhausting its capacity. By contrast, priming the relationship with an accepting other likely puts a low strain on working memory. Indeed, to the extent that accepting others provide a rewarding psychological context in which one feels accepted unconditionally, priming an accepting relationship may even help individuals to free up working memory capacity (cf. Koole et al., 2005; Koole, Kuhl, Jostmann, & Finkenauer, 2006). In sum, visualizing a demanding person may induce a psychological context of high demand, whereas visualizing an accepting person may induce a psychological context of low demand.

Following the demand manipulation, we administered a set of validated measures of working memory capacity. In Study 1, we measured working memory capacity by means of an OSPAN task (Turner & Engle, 1989). In Study 2, we measured working memory capacity by means of an intention memory task (Goschke & Kuhl, 1993). Given that working memory capacity is functionally linked with intention memory (Kazén & Kuhl, 2005), we expected parallel effects on the intention memory task and the OSPAN task. Specifically, we predicted that action-oriented individuals would better utilize their working memory capacity under high demands such that visualizing a demanding relationship leads to higher span scores (Study 1) and better intention memory (Study 2) than visualizing an accepting relationship. By contrast, we predicted that state-oriented individuals' working memory would choke under high demands such that visualizing a demanding relationship leads to lower span scores and worse intention memory than visualizing an accepting relationship.

STUDY 1

Method

PARTICIPANTS AND DESIGN

Seventy-four paid volunteers at the Vrije Universiteit Amsterdam (28 men, 46 women, average age = 20) participated in the experiment. The experimental design was 2 (orientation: action vs. state) × 2 (visualization: demanding vs. accepting) between participants. Participants were randomly assigned to the demanding (n = 35) or the accepting (n = 39) condition. The main dependent variable consisted of the number of correctly remembered words during the OSPAN task.

PROCEDURE

Upon arrival in the laboratory, participants were led into individual cubicles, each containing a computer. Experimental instructions were administered via a computer program. Participants were first informed that they would participate in several unrelated studies that were allegedly administered together for efficiency reasons. Participants then moved on with the first study, which was introduced as a study on personality and contained our assessment of individual differences in action versus state orientation. Next, participants continued with a visualization task during which either high or low levels of demand were induced. Subsequently, participants performed the OSPAN task. After this, participants answered a manipulation check and provided some biographical information. Finally, participants were debriefed, thanked, and paid by the experimenter.

INDEPENDENT VARIABLES

Individual differences. To assess individual differences in action versus state orientation, we used a Dutch translation of the Action Control Scale (ACS-90; Kuhl, 1994). In both studies, we administered the demand-related (AOD) and the threat-related (AOT) subscale of the ASC-90.[2] According to PSI theory (Kuhl, 2001, p. 243; cf. Baumann et al., 2005; Koole & Jostmann, 2004), demand and threat represent different aversive states each related to different trigger conditions and different symptoms. AOD measures whether a person is decisive and active (action-oriented) or indecisive and inertial (state-oriented) under high demands. By contrast, AOT measures whether a person becomes challenged (action-oriented) or remains threatened (state-oriented) in situations that are perceived as dangerous to one's well-being or self-image (cf. Blascovich & Mendes, 2000). We found no effects of AOT in the present investigation, which indicates that our manipulation did not trigger challenge and threat processes, all *F*s < 1. We therefore report only effects of AOD. For the sake of convenience, we use the more general term "action versus state orientation" throughout this article to refer to AOD unless a more precise distinction is required.

The AOD subscale consists of 12 items, which were intermingled and presented in a different random order for each participant. Each item describes a demanding situation and an action-oriented versus state-oriented way of coping with that situation. For each item, participants are asked to select the response that best described their own reaction in that situation. An example item is as follows: "When I have a lot of important things to do and they must all be done soon: (a) I often don't know where to begin or (b) I find it easy to make a plan and stick with it." In this example, option (a) reflects the state-oriented response and option (b) reflects the action-oriented response. Action-oriented responses were coded as 1 and state-oriented responses were coded as 0 and summed for the entire subscale. Reliability for the AOD scale was sufficient (Kuder-Richardson, KR, 20 coefficient = .78). Scores could range from 0 to 12. Participants who gave seven or more action-oriented responses were assigned to the action-oriented group ($n = 42$); participants who gave six or fewer action-oriented responses were assigned to the state-oriented group ($n = 37$).[3]

Visualization manipulation. The visualization procedure was modeled after Baldwin and Sinclair (1996). During the procedure, which was introduced as a visualization exercise, participants were asked to visualize a particular person from their own life. In the demanding condition, participants were requested to think of a person who was highly demanding of them. Participants had to type in the initials of this person, which were used throughout the exercise in referring to the visualization target. Participants were instructed to vividly imagine being with this person and to reexperience their thoughts and feelings associated with this person. At various stages during the visualization, participants typed in the experiences that were evoked by the visualization. At the end of the exercise, participants were asked to rate their ease of visualization. In the accepting visualization condition, participants went through the same procedure but instead visualized a person who was highly accepting of them.

DEPENDENT MEASURE

Working memory task. To measure working memory capacity we used a computerized version of the OSPAN task adapted from Schmader and Johns (2003; cf. Turner & Engle, 1989). The OSPAN task interleaves short series of words to memorize with simple mathematical equations to be evaluated. In the present investigation, each equation began with the multiplication or division of two positive integers (e.g., 5×7). The product of this operation then had to be added to, or subtracted from, another positive integer. For each equation, the answer was included in the expression. The task of the participants was to evaluate by means of a key-press whether the equation was correct or incorrect, for example, "Is $(5 \times 7) - 12 = 23$?" When the equation was correct, participants had to press the "A" button on the left side of the keyboard, whereas they had to press the "6" button on the numeric pad on the right side of the keyboard when the equation was incorrect. After each equation, a word to memorize was presented. After a series of equation word pairs (i.e., a set), participants were requested to type in all words they recalled from the preceding set. After this, a new set of equation word pairs started.

Sets differed in length varying from three to five equation word pairs per set. Six sets of each length were presented, allowing scores to range from 0 to 72. Presentation order of the sets was randomized for each participant, such that the number of words to recall was unknown until recall. The generation of mathematical equations followed the criteria of Schmader and Johns (2003). Half of the equations were correct, and the remaining equations were incorrect. The 72 words used in the test were monosyllabic Dutch nouns that were randomly assigned to sets. Within sets, equation word pairs were presented in a different random order for each participant. The assignment of equations and words to sets was identical for all participants.

Each trial within a set began with the appearance of a fixation asterisk on the screen for 1 s followed by an equation, which remained visible until participants had pressed a response key. After this, the screen remained blank for 500 ms, followed by the appearance of a word to be recalled. After 2 s, the screen went blank again for 1 s, followed by the next trial. Sets were separated by the announcement "next set," which remained visible for 3 s. The computer unobtrusively recorded the words recalled, participants' responses on the equations, and the time spent on each equation.

Results

Manipulation check. At the end of the experimental session, participants were asked to rate on two items how demanding and how accepting the person was whom they had visualized (1 = *not at all*, 9 = *very much*). These items were scored in the same direction and averaged (Cronbach's α = .88). The visualized person was rated as more demanding in the demanding condition than in the accepting condition, $F(1, 70) = 74.08$, $p < .001$, $\eta_p^2 = .51$ ($M = 5.61$ vs. $M = 2.68$). No effects of action versus state orientation were found on this index, all Fs < 1.

OSPAN performance. Span scores were assessed by counting the total number of correctly recalled words. (Redoing the analyses with the number of correctly recalled words only from sets where all the words in the set were recalled correctly yielded equivalent results; cf. Schmader & Johns, 2003.) We subjected average span scores to a 2 (orientation: action vs. state) × 2 (visualization: demanding vs. accepting) ANOVA, which yielded a significant interaction, $F(1, 70) = 11.17$, $p < .002$, $\eta_p^2 = .14$. Relevant means are displayed in Table 1. Simple effects analyses revealed that action-oriented participants displayed marginally higher span scores in the demanding condition than in the accepting condition, $F(1, 70) = 5.89$, $p < .06$, $\eta_p^2 = .08$ ($M = 69.00$ vs. $M = 66.21$). By contrast, state-oriented participants had significantly lower span scores in the demanding condition than in the accepting condition, $F(1, 70) = 5.31$, $p < .03$, $\eta_p^2 = .07$ ($M = 66.05$ vs. $M = 68.80$). Another way to interpret the data is to note that in the demanding condition, action-oriented participants had higher span scores than did state-oriented participants, $F(1, 70) = 6.11$, $p < .02$, $\eta_p^2 = .08$ ($M = 69.00$ vs. $M = 66.05$). In the accepting condition, however, the pattern was reversed, such that action-oriented participants had lower span scores than did state-oriented participants, $F(1, 70) = 5.07$, $p < .03$, $\eta_p^2 = .07$ ($M = 66.21$ vs. $M = 68.80$).

TABLE 1: Operation Spans (OSPAN) as a Function of Visualization and Orientation (Study 1)

	Visualization	
Orientation	*Accepting*	*Demanding*
Action	66.21 (4.21)[a]	69.00 (1.65)[b]
State	68.80 (1.82)[c]	66.05 (4.37)[d]

NOTE: Scores could range from 0 (low OSPAN) to 72 (high OSPAN). Standard deviations appear in parentheses.
a. $n = 24$.
b. $n = 15$.
c. $n = 15$.
d. $n = 20$.

Supplementary analyses. Additional analyses revealed that the results remained identical when we controlled for the number of correctly evaluated equations (Grand $M = 88\%$). Moreover, we found no effects of orientation or visualization on the number of correctly evaluated equations, all Fs < 1.

Discussion

As predicted, the effects of situational demands on working memory capacity were moderated by action versus state orientation. Among action-oriented participants, priming a demanding relationship context made them utilize their working memory capacity more efficiently than priming an accepting relationship context, as indicated by participants' OSPAN scores. Action-oriented individuals thus utilized their working memory capacity especially under demanding conditions. By contrast, state-oriented participants displayed higher span scores after priming an accepting compared to a demanding relationship. State-oriented individuals thus utilized their working memory capacity especially under low-demanding conditions. Stated differently, priming a demanding relationship led to better utilization of working memory capacity among action- compared to state-oriented participants, whereas the reverse was true after priming an accepting relationship.

STUDY 2

Study 2 examined the effects of situational demands and action versus state orientation on intention memory. As discussed before, working memory capacity is required for the preparation of intentional action. Accordingly, a person's working memory capacity may be reflected in her or his ability to maintain explicit representations of intentions (Kane & Engle, 2003).

The intention memory task in Study 2 differed in several meaningful ways from the OSPAN task in Study 1. The OSPAN task represents a dual-task situation, in which participants have to memorize information while they are simultaneously processing unrelated information. Neither type of information is relevant for the preparation of action. By contrast, the intention memory task did not involve dual-task conditions and the information processed in the task was relevant for action preparation. Consequently, extending our empirical analysis to intention memory provided additional insights into how people utilize their working memory capacity for the purpose of future action.

To assess intention memory, we used the *postponed intention task* (Goschke & Kuhl, 1993). In this task, participants have to learn a pair of short scripts describing activities (e.g., "clear a desk") that entail several intermediate steps (e.g., "sharpen the pencils"). After participants have learned both scripts, they are informed that they have to execute one of the scripts later (*prospective script*). The other script (*neutral script*) does not have to be executed by the participants. During a subsequent recognition task, participants then have to decide whether words presented on the computer screen had appeared in one of the two scripts. Using this paradigm, past research has found evidence for an *intention superiority effect*, that is, faster recognition latencies for words from the prospective script compared to words from the neutral script (Goschke & Kuhl, 1993).

Based on the theoretical link between working memory capacity and intention memory (cf. Kazén & Kuhl, 2005), we predicted that action versus state orientation would moderate the impact of demands on intention memory performance in Study 2 much like it did on OSPAN performance in Study 1. Specifically, we predicted that action-oriented participants would display a greater intention superiority effect under high-demanding conditions than under low-demanding conditions. By contrast, we predicted that state-oriented participants would display a greater intention superiority effect under low-demanding than under high-demanding conditions.

Method

PARTICIPANTS AND DESIGN

One hundred and twenty-six paid volunteers at the Vrije Universiteit Amsterdam (44 men, 82 women, average age = 21) participated in the experiment. The experimental design was 2 (orientation: action vs. state; between participants) × 2 (visualization: demanding vs. accepting; between participants). Participants were randomly assigned to the demanding ($n = 62$) or the accepting ($n = 64$) visualization conditions. The main dependent variable consisted of participants' mean recognition times and number of correctly remembered words from the prospective and the neutral script. Seven participants (5.5% of the entire sample) failed to recognize any words from the neutral script. Because all participants recognized at least some words of the prospective script, these 7 participants had probably misunderstood the task instructions that they should respond to words of both scripts. Because it was not possible to measure intention superiority effects in recognition times for these participants, they were removed from the dataset. One additional participant (.8% of the entire sample) was excluded because he incorrectly indicated that the neutral script had to be executed.

PROCEDURE

The equipment and general procedure were similar to Study 1. Participants first answered a few questionnaires including the AOD subscale of the ASC-90 (Kuhl, 1994) to assess individual differences in action orientation (KR 20 = .73). Based on their responses, 69 participants were assigned to the state-oriented group, whereas 57 participants were assigned to the action-oriented group. Next, participants continued with a practice trial of the postponed intention task. The scripts used in the practice postponed intention task were different from those used during the actual postponed intention task. After the practice trial, participants performed the visualization task. Subsequently, participants went on with the actual postponed intention task during which responses where recorded for analysis. Next, participants performed some unrelated tasks followed by a manipulation check. Finally, participants were debriefed, thanked, and paid for their participation.

DEPENDENT MEASURE

Postponed intention task. The postponed intention task was adapted from Goschke and Kuhl (1993) and consisted of a learning phase, a distracter task, the presentation of the execution instruction, and a recognition test. The postponed intention task was described to the participants as a study on people's memory for simple activities. Participants were informed that they would receive descriptions of two simple activities on the computer screen. Participants expected that they had to learn these descriptions, which were referred to as "scripts," and that their memory for both scripts would be tested in a recognition test. Furthermore, it was stressed that participants would have to execute one of the two scripts later during the experiment. Which of the two scripts would be executed was randomly determined by the computer.

The scripts consisted each of a script header (e.g., "setting a table") and four propositions describing component activities (e.g., "distribute the plates"). The learning phase started with the script header of the first script appearing on the screen followed by separate presentations of each of the four component activities. The header and the components of the script were each displayed for 6 s. Subsequently, the entire script was displayed for another 30 s. After this, the second script was presented in an identical way. Subsequently, the entire procedure was repeated such that both scripts were presented two times to the participants. Next, participants proceeded with a short distracter task during which they had to count backward in steps of three from a three-digit number for 45 s. Subsequently, participants received the instruction for which of the two scripts they had to execute. The instruction consisted of the word "execute" followed by one of the script headers (the prospective script). In a second row, the words "do not execute" were displayed followed by the second script header (the neutral script). This execution instruction was displayed for 6 s. Assignment of the two scripts was counterbalanced between participants such that each script served equally often as the prospective script and the neutral script, respectively.

Immediately after the presentation of the execution instruction, participants received a recognition test, during which single words were presented on the screen. Participants were required to indicate for each word whether they had seen that word in one of the two scripts. If the word was identified as a word from one of the two scripts, participants were to press the "A" key on the left side of the keyboard. When the word was identified as a new word, participants were to press the "6" key on the numeric pad on the right side of the keyboard. Participants were further told to respond quickly and accurately and to guess whenever they were not sure about the correct response.

The recognition test started with four warm-up trials. After this, 44 words were presented sequentially to the participants. Half of the words were derived from one of the two scripts; the remaining words were new. Half of the new words were semantically related to respectively one of the scripts; the remaining new words were semantically unrelated to either script. Each word remained on the screen until participants gave a response. The screen then remained blank for 1.5 s. The computer unobtrusively recorded participants' responses and response latencies. After the recognition test, participants had to indicate which script had to be executed. Actual execution of the prospective script was only required during the practice postponed intention task.

Results

Manipulation checks. At the end of the experimental session, participants were asked to rate how demanding and how accepting the person was whom they had visualized (1 = *not at all*, 9 = *very much*). These two items were scored such that higher scores indicated higher perceived demandingness of the visualized person (Cronbach's $\alpha = .54$). Given the low reliability coefficient, we conducted a 2 (orientation) × 2 (visualization) multivariate analysis of variance (MANOVA) on participants' responses on the two items, which revealed a main effect of visualization, $F(1, 117) = 64.93$, $p < .001$, $\eta_p^2 = .36$. On average, the person who was visualized in the demanding condition was perceived as more demanding than the person who was visualized in the accepting condition ($M = 5.59$ vs. $M = 3.40$). (We report averaged scores to facilitate interpretation.) The analysis also yielded a main effect of orientation, $F(1, 117) = 6.62$, $p < .02$, $\eta_p^2 = .05$. State-oriented participants rated the visualized person as more demanding than action-oriented participants ($M = 4.74$ vs. $M = 4.14$). The interaction between orientation and visualization was not significant, $F(1, 117) = 1.76$, $p = .19$, $\eta_p^2 = .02$.

Recognition times. Following Goschke and Kuhl (1993), we first eliminated errors (i.e., the number of script words that were not recognized, 16.2% of all responses) and responses lower than 300 ms (1.6% of all responses). Analyses on recognition latencies were conducted on log-transformed data to normalize the distribution (Ratcliff, 1993). To facilitate interpretation, we report untransformed means in ms.

We proceeded by subtracting average recognition latencies for words from the prospective script from average recognition latencies for words from the neutral script. The resulting difference scores index the intention superiority effect, that is, better memory for prospective script words compared to neutral script words. A 2 (orientation: action vs. state) × 2 (visualization: demanding vs. accepting) ANOVA confirmed the predicted two-way interaction effect between orientation and visualization, $F(1, 114) = 10.59$, $p < .002$, $\eta_p^2 = .09$. Relevant means are displayed in Table 2. Action-oriented participants displayed a larger intention superiority effect in the demanding condition than in the accepting condition, $F(1, 114) = 6.20$, $p < .02$, $\eta_p^2 = .06$ ($M = 121$ vs. $M = -71$). Simple t tests revealed a significant intention superiority effect among action-oriented participants in the demanding conditions, $t(26) = 2.86$, $p < .009$, but not in the accepting condition, $t < 1$. By contrast, state-oriented participants had a smaller intention superiority effect in the demanding condition than in the accepting condition, $F(1, 114) = 4.40$, $p < .04$, $\eta_p^2 = .04$ ($M = -47$ vs. $M = 105$). Simple t tests revealed a significant intention superiority effect among state-oriented participants in the accepting condition, $t(33) = 2.53$, $p < .02$, but not in the demanding condition, $t < 1$.

Another way of interpreting the Orientation × Visualization interaction is to note that in the demanding condition, action-oriented participants showed a larger

TABLE 2: Average Response Latencies (ms) for Prospective and Neutral Words and Intention Superiority Effect as a Function of Visualization and Orientation (Study 2)

	Visualization					
	Accepting			*Demanding*		
	Word Type			*Word Type*		
Orientation	*Prospective*	*Neutral*	*ISE*	*Prospective*	*Neutral*	*ISE*
Action	1,401 (387)	1,329 (570)	–71 (487)[a]	1,136 (302)	1,257 (406)	121 (236)[b]
State	1,241 (347)	1,346 (418)	105 (399)[c]	1,314 (399)	1,266 (288)	–47 (348)[d]

NOTE: ISE = Intention Superiority Effect (Neutral–Prospective). Standard deviations appear in parentheses.
a. $n = 26$.
b. $n = 27$.
c. $n = 34$.
d. $n = 31$.

intention superiority effect than did state-oriented participants, $F(1, 114) = 4.05$, $p < .05$, $\eta_p^2 = .03$ ($M = 121$ vs. $M = -47$). In the accepting condition, we found a significant reversal of the pattern. Specifically, action-oriented participants displayed a lower intention superiority effect than did state-oriented participants, $F(1, 114) = 6.72$, $p < .02$, $\eta_p^2 = .06$ ($M = -71$ vs. $M = 105$).

Supplementary analyses on recognition times. Additional analyses revealed that the effects on recognition latencies remained intact when we statistically controlled for error rates. Furthermore, the examination of intention memory effects during the practice task revealed that action-oriented ($M = 83$) and state-oriented participants ($M = 84$) had similar intention memory effects under such neutral conditions, $F < 1$. When we included intention memory during the practice task as a covariate, the Orientation × Visualization interaction on intention memory during the actual task remained significant.

Recognition accuracy. Following Goschke and Kuhl (1993), we computed from the hit rates and false-alarm rates a discriminability index A' that was proposed by Pollack (1970) as a nonparametric equivalent to d' and that can be calculated even when the number of observations is small. Chance performance is reflected by an A' value of .5, whereas perfect performance yields an A' of 1.0. For each participant, we calculated A' separately for neutral and prospective words.[4] Discriminability indices A' were subjected to a 2 (orientation) × 2 (visualization) × 2 (script type: prospective vs. neutral) ANOVA with repeated measures on the last factor. This analysis yielded only a significant main effect for script type, $F(1, 114) = 11.20$, $p < .002$. Specifically, A' values for prospective words were higher ($A' = .81$) than A' values for neutral words ($A' = .78$). The analysis revealed no effects of orientation or visualization, all Fs < 1.

Discussion

The results of Study 2 confirmed that action versus state orientation moderates the impact of situational demands on intention memory. Action-oriented participants displayed a significant intention superiority effect after priming a demanding relationship but not after priming an accepting relationship. Among state-oriented participants, however, this pattern was reversed such that state-oriented participants displayed a significant intention superiority effect after priming an accepting relationship but not after priming a demanding relationship. The results also can be interpreted separately by demand condition. After priming a demanding relationship, action-oriented participants thus had a greater intention memory effect than state-oriented participants, whereas the reverse was true after priming an accepting relationship.

Notably, intention superiority effects between action- and state-oriented participants did not differ during the practice task. Because demand was not yet manipulated before the practice task, this lack of an effect suggests that action- versus state-oriented individuals do not differ in intention memory under neutral conditions. Moreover, a covariance analysis revealed that that the effects of demand on intention memory were independent from individual differences in intention memory under neutral conditions. Of course, such interpretations should be made with caution given the inherent difficulties in drawing conclusions from null findings.

Our manipulation checks found that state-oriented participants perceived the visualized person in both conditions as somewhat more demanding compared to action-oriented participants. Even though this effect was not anticipated, it could not explain the observed effects of action versus state orientation on intention memory. First, effects of action versus state orientation on intention memory were moderated by situational demands, and no such moderation effect was obtained on the manipulation check. Second, when we included the manipulation check as a covariate, the Orientation × Visualization interaction on intention memory remained significant.

GENERAL DISCUSSION

Past research and theorizing have described inconsistent effects of demands on working memory capacity. On one hand, research has found that working memory is prone to "choking under pressure" (Baumeister, 1984) in that people utilize their working memory capacity less efficiently in demanding situations. On the other hand, recent notions on top-down control processes suggest that high demands may serve as a mobilization signal to utilize working memory capacity more efficiently (c.f., Botvinick et al., 2001). The present research suggests that these apparent inconsistencies can be resolved by considering the role of action versus state orientation as a moderator of the effects of situational demands. The choking pattern is more characteristic of state-oriented individuals, who utilize their working memory capacity less efficiently with increasing demands. The mobilization pattern, on the other hand, is more characteristic of action-oriented individuals, who better utilize their working memory capacity with increasing demands.

In two studies, action-oriented participants utilized their working memory capacity more efficiently after visualizing a demanding relationship compared to an accepting relationship. State-oriented participants displayed the opposite pattern: They had less working memory capacity available after visualizing a demanding relationship compared to an accepting relationship. Stated differently, action-oriented participants better utilized their working memory capacity than did state-oriented participants after visualizing a demanding relationship, whereas the reverse was true after visualizing an accepting relationship. These effects were robust across two very different measures of working memory capacity, that is, OSPAN (Study 1) and intention memory (Study 2). Taken together, the present research highlights the importance of action versus state orientation in the use of working memory capacity under varying levels of situational demand.

Why would working memory choke under high demands among state-oriented individuals? Presumably, state-oriented individuals' tendency toward indecisiveness and hesitation (Kuhl, 1984) renders them less capable of updating their working memory. Consequently, state-oriented individuals will be unable to terminate the sustained working memory load that is induced by high-demanding conditions. This, in turn, leaves less working memory capacity available for subsequent tasks. Under low-demanding conditions, working memory is less loaded than under high-demanding conditions. Consequently, it is less relevant to update working memory under low-demanding conditions. Moreover, low-demanding conditions can even help state-oriented individuals to update their working memory, particularly when conditions are rewarding. Visualizing an accepting relationship likely provided such rewarding context, thereby making more working memory capacity available for state-oriented individuals to use in subsequent tasks.

Unlike their state-oriented counterparts, action-oriented participants better utilized their working memory capacity under high- compared to low-demanding conditions. A likely explanation for this pattern is that action-oriented individuals have a tendency toward decisiveness and initiative (Kuhl, 1984), which renders them more capable of updating the contents of their working memory. Under high demands, action-oriented individuals are more inclined to update working memory, thereby making more working memory capacity available for subsequent tasks. By contrast, low-demanding conditions do not trigger compensatory updating of working memory among action-oriented individuals and thus do not lead to more efficient use of working memory capacity. Moreover, action-oriented individuals are less receptive to rewarding contexts than are state-oriented individuals (Koole et al., 2005). Consequently, visualizing an accepting person does not necessarily facilitate working memory among action-oriented individuals.

Action-oriented individuals thus utilize their working memory capacity most efficiently under demanding conditions, whereas state-oriented individuals utilize their working memory capacity most efficiently under rewarding or accepting conditions. This overall pattern suggests that having an action orientation is more compatible with a demanding context, whereas having a state orientation is more compatible with a rewarding or accepting context. Despite the observed advantage of state-oriented individuals under rewarding conditions, however, it is important to note that rewarding or accepting conditions often may be lacking in common situations such as at work or during one's study (cf. Diefendorff et al., 1998). Accordingly, action orientation may prove more advantageous than state orientation in many achievement contexts.

The present research further highlights the role of relationship schemas for the regulation of basic cognitive processes. Previous work has shown that priming relationship schemas activates correspondent goal representations and expectations (e.g., Fitzsimons & Bargh, 2003; cf. Chen et al., 2006). The present findings add to this literature that relationship schemas even influence the efficiency of basic memory functions such as working memory capacity. The present research thus reveals an important connection between interpersonal and intrapersonal processes (cf. Vohs & Finkel, 2006).

Limitations and Avenues for Future Research

The present research has several limitations and thus leaves important issues open for further investigation. First, unlike previous research (e.g., Van der Linden et al., 2003), we did not find main effects of demands on measures of working memory capacity. Previous research did not include measures of action versus state orientation. It is thus possible that previous research has unwittingly relied on either predominately state-oriented or predominately action-oriented samples. It is equally conceivable that previous manipulations have induced much different levels of demand than the present visualization manipulation. For instance, Van der Linden and colleagues (2003) had participants engage in a demanding task for 2 hours. It seems likely that even action-oriented individuals use their working memory capacity less efficiently under such extreme demands.

Another important issue concerns the regulation of working memory capacity under threatening conditions. Previous research has found that people utilize their working memory capacity less efficiently as a result of stereotype threat (Schmader & Johns, 2003) and math anxiety (Ashcraft & Kirk, 2001). However, theoretical considerations suggest that people may be able to convert feelings of threat into feelings of challenge under conditions that potentially jeopardize their self-image or well-being (Blascovich & Mendes, 2000). Based on PSI theory (Kuhl, 2001), we suggest that action versus state orientation on the threat-related dimension (AOT) may be an important moderator of working memory capacity under threat. Specifically, threat-related action orientation may lead to the mobilization of working memory capacity under conditions of stereotype threat or math anxiety, whereas threat-related state orientation may lead to choking under pressure. Future research may explore this intriguing possibility.

Concluding Remarks

Working memory is a vital psychological function that allows people to remember important information even when they are temporarily distracted. Past research and theorizing has made inconsistent predictions whether working memory capacity is utilized more efficiently or less efficiently under high situational demands. In the present research, we have suggested that these conflicting notions can be reconciled by considering the role of action versus state orientation. In particular, action-oriented individuals used their working memory capacity most efficiently under high-demanding conditions, whereas state-oriented individuals used their working memory capacity most efficiently under low-demanding conditions. The present research thus illuminates how different individuals dynamically regulate the waxing and waning of working memory.

NOTES

1. A correlational analysis (Koole, 2005) on undergraduates' responses ($N = 67$) on the Action Control Scale (ASC-90; Kuhl, 1994) and the Regulatory Focus Questionnaire (Higgins et al., 2001) revealed that the demand-related subscale of the ASC-90 (AOD) correlates moderately with both promotion ($r = .42$, $p < .001$) and prevention focus ($r = .35$, $p < .003$).

2. The labels "demand-related" and "threat-related" action orientation were suggested by Koole and Jostmann (2004) as alternatives for the original "decision-related" and "failure-related" action orientation, respectively (Kuhl, 1994). The new denotations fit better with relevant constructs within personality systems interactions (PSI) theory (Kuhl, 2001).

3. In the present research, we split our samples at the conceptual midpoint of the AOD scale, which corresponds to the normative midpoint based on a large-scale study among Dutch university students ($N = 1{,}457$; Koole, 2003). We further examined our data in Studies 1 and 2 using a regression approach. In Study 1, the Orientation × Visualization interaction on Operation Span (OSPAN) was significant, $\beta = .271$, $t(73) = 2.35$, $p < .03$, $R^2 = .08$. In Study 2, the Orientation × Visualization interaction on the intention superiority effect also was significant, $\beta = .237$, $t(117) = 2.60$, $p < .02$, $R^2 = .06$. Thus, a regression approach yielded results equivalent to an ANOVA approach. Because a regression approach made it difficult to inspect the absolute means of the dependent variables, we report the ANOVA results in the main body of this article.

4. A' was calculated according to the following formulas: (a) if H > FA, $A' = .5 + (H - FA)(1 + H - FA)/4H(1 - FA)$, (b) if H = FA, $A' = .5$, and (c) if H < FA, $A' = .5 - (FA - H)(1 + FA - H)/4FA(1 - H)$, where H is the hit rate and FA is the false alarm rate.

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